ADIKAVI NANNAYA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY

RAJAMAHENDRAVARAM - 533296

DEPARTMENT OF BIOCHEMISTRY

M.Sc BIOCHEMISTRY SYLLABUS

(W.e.f 2019-2020 A.B)

PROGRAM STRUCTURE –(2019-20)

S.No	Course Code	Title	Total Marks	Internal Exam Marks	Sem End Exam Marks	Teaching Hours/ week	Credits
SEMESTER I							
1		Cell Biology	100	25	75	4	4
2		Biomolecules	100	25	75	4	4
3		Microbiology	100	25	75	4	4
4		Analytical Techniques	100	25	75	4	4
LAB COURSE							
5		Cell Biology lab	50	12	38	3	2
6		Biomolecules lab	50	12	38	3	2
7		Microbiology lab	50	12	38	3	2
8		Analytical Techniques lab	50	12	38	3	2
SEMESTER II							
9		Molecular Biology	100	25	75	4	4
10		Enzymology	100	25	75	4	4
11		Immunology	100	25	75	4	4
12		Bioinformatics and Biostatistics	100	25	75	4	4
LAB COURSE							
13		Molecular Biology lab	50	12	38	3	2
14		Enzymology lab	50	12	38	3	2
15		Immunology lab	50	12	38	3	2
16		Bioinformatics and Biostatistics lab	50	12	38	3	2
SEMESTER III							
17		Endocrinology	100	25	75	4	4
18		Physiology and Bioenergetics	100	25	75	4	4
19		Intermediary Metabolism	100	25	75	4	4
20		Gene regulation and Genetic Engineering	100	25	75	4	4
LAB COURSE							

21		Endocrinology lab	50	12	38	3	2
22		Physiology and Bioenergetics lab	50	12	38	3	2
23		Intermediary Metabolism lab	50	12	38	3	2
24		Gene regulation and Genetic Engineering lab	50	12	38	3	2
SEMESTER IV							
25		Plant and Environmental Biochemistry	100	25	75	4	4
26		Clinical Biochemistry and Human Nutrition	100	25	75	4	4
27		Applied Biochemistry and cancer biology	100	25	75	4	4
28		Omics, Bioethics and Research Methodology	100	25	75	4	4
LAB COURSE							
29		Plant and Environmental Biochemistry lab	50	12	38	3	2
30		Clinical Biochemistry and Human Nutrition lab	50	12	38	3	2
31		Applied Biochemistry and cancer biology lab	50	12	38	3	2
32		Omics, Bioethics and Research Methodology lab	50	12	38	3	2
33		Comprehensive Vive-voce	100				4

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PROGRAM OUTCOME
M.Sc BIOCHEMISTRY

On Successful completion of the programme, the student will:

- Understand the structure, molecular mechanisms and function of biomolecules with a focus on the metabolic processes within living organisms.
- Gain knowledge in the mechanism of pathology of diseases, clinical diagnosis, drug designing by studying their metabolism, manufacturing various biological products such as antibiotics, hormones, enzymes, etc.
- Learn the fundamentals and advanced biochemistry and its vital applications in nutritive values by studying the recommended dietary allowances of each macro and micronutrients
- Understand the concepts of biochemical techniques applied in various fields such as molecular biology, tissue culture, stem cells, cancer biology, metabolic and physiological processes of living system.
- Gain the practical knowledge ranging from basic biochemistry courses such as biomolecules, enzymology, cell biology, immunology to indepth advanced courses like endocrinology, genetic engineering, proteomics, genomics, statistical approach.
- Also learn research articles and research proposal writing which will benefit the student to design, standardize and record the results of biochemical experiments using classical analytical techniques, modern instruments and computers to interpret the data with accurate conclusions.

CAREER OPPORTUNITIES :

Upon completion of Program students will:

- Find career options as scientists and research personnel in both private and national research institutes such as Centre for Cellular and Molecular Biology, Indian Institute of Chemical Technology, Indian Council for Medical Research.

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- Find employment in research and development laboratories, biopharmaceutical companies like Biocon, Serum Institute of India, Biocon, Panacea Biotech, Dr. Reddy's Laboratories
- Grab opportunity as biochemical analysts in clinical and diagnostic centres and in medical care industries like Reliance Life sciences, Ranbaxy Laboratories
- Excell as Biochemists in multinational companies like Pfizer, Bharat Biotech, Arabindo pharma.

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Mapping of Courses having focus on Employability / Skill Development / Course Possess Entrepreneurship

S.No	Title	Does the Course Provides Employability	Does the Course Provides Skill Development	Does the Course Provides Entrepreneurship
1	Cell Biology	√	.....	.....
2	Biomolecules	√	.....	.....
3	Microbiology	√	.....	.....
4	Analytical Techniques	√	.....	.....
5	Molecular Biology	√	.....	.....
6	Enzymology	√	.....	.....
7	Immunology	√	.....	.....
8	Bioinformatics and Biostatistics	√	.....	.....
9	Endocrinology	√	.....	.....
10	Physiology and Bioenergetics	√	.....	.....
11	Intermediary Metabolism	√	.....	.....
12	Gene regulation and Genetic Engineering	√	.....	.....
13	Plant and Environmental Biochemistry	√	.....	.....
14	Clinical Biochemistry and Human Nutrition	√	.....	.....
15	Applied Biochemistry and Cancer Biology	√	.....	.....
16	Omics, Bioethics and Research Methodology	√	.....	.....
LAB COURSE				
17	Cell Biology lab	.....	√	.....
18	Biomolecules lab	.....	√	.....
19	Microbiology lab	.....	√	.....
20	Analytical Techniques lab	.....	√	.....
21	Molecular Biology lab	.....	√	.....
22	Enzymology lab	.....	.....	.....
23	Immunology lab	.....	√	.....
24	Bioinformatics and Biostatistics lab	.....	√	.....
25	Plant and Environmental Biochemistry lab	.....	√	.....
26	Endocrinology lab	.....	√	.....
27	Physiology and Bioenergetics lab	.....	.....	.....
28	Intermediary Metabolism lab	.....	√	.....
29	Gene regulation and Genetic Engineering lab	.....	√	.....
30	Clinical Biochemistry and Human Nutrition lab	.....	√	.....
31	Applied Biochemistry and cancer biology lab	.....	√	.....
32	Omics, Bioethics and Research Methodology lab	.....	√	.....
33	Comprehensive Vive-voce	.....	.....	.....

SEMESTER – I
COURSE-I
CELL BIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end the course aims to provide the students:

- The basic knowledge on structures and functions of prokaryotic and eukaryotic cells to the students
- The detailed study of structure, composition, functional role of cell organelles and their components in the physiological processes, cell cycle and cell division
- Understand the structural organization and the role of cellular components in the living organisms
- Understand metabolic activities of the cell for genetic engineering of cells inorder to develop new transgenic cells

Students upon completion of this course will find opportunities as cell biologists and scientists in cell culture laboratories

Unit I:

Structure of a typical cell, Differences between prokaryotic and eukaryotic cells; Structural organization and functions of nucleus, endoplasmic reticulum, golgi complex. lysosomes, vacuole, microbodies, ribosomes.

Unit II:

Structural organization and chemical composition of cell membrane, symmetry of the membrane; membrane fluidity; membrane structure models, membrane transport - active transport; active transport of Na^+ K^+ (Sodium potassium ATPase) Ca^{2+} (Ca^{2+}-ATPase); active transport of sugars coupled to phosphorylation; Passive transport - anion exchange proteins; Donnan membrane equilibrium, group translocation (γ-Glutamyl cycle).

Unit III:

Mitochondria - Structural organization, composition and functions; mitochondrial respiratory chain; mechanism of oxidative of phosphorylation; Chloroplast - Structural organization, composition, components and functions of chloroplast.

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Unit IV:

Cell cycle – phases and events of cell cycle; Cell division - Mechanism of mitosis and meiosis; Regulation of cell cycle - Molecular events including cell cycle check points and CDK – cyclin complexes, tyrosine kinases; Programmed cell death - apoptosis.

Suggested Reading:

1. EDP de Robertis and EMF deRobertis (2017)."Cell and Molecular Biology", 8th edition
2. Lodish Baltimore L (1999). "Cell and Molecular Biology".4th edition.W.H.Freeman& Co Ltd
3. GM Cooper and Hausman (2013)."The Cell, A molecular Approach", 6th edition (Ed), Sinauer Associates Inc, India
4.B.Alberts etal. (2014)."Molecular Biology of the Cell". 6th Edition. Garland publicationsincorporation, USA
5. J. Darnell, (1990). "Molecular Cell Biology", 2nd Edition. Scientific AmericanBooks.USA
6. P.K.Gupta (2005). "Cell and Molecular Biology", 5th Edition, Rastogi Publ. India

SEMESTER – I
COURSE-II
BIOMOLECULES

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to provide the students:

- A fundamental knowledge on macromolecules such as proteins, carbohydrates, lipids and nucleic acids in the living system
- An overview on the structure, classification, physicochemical properties and biological role of macromolecules
- Knowledge of classification, structure and functions of nucleic acids and their biological role
- A deep understanding about lipids, their derivatives and importance
- Acquaintance on basics of biomolecules, their importance in the cellular functions and their role in nature and understand every aspect of biological systems at the molecular level

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Students after this course completion will find opportunities as biochemists in medical labs and in pharma industries

Unit I:

Chemical foundations and chemical bonding of biology;Amino acids – classification, structure and physicochemical properties, Peptide bond – structure; Proteins – classification, structural organization, physicochemical properties;Isolation, purification, sequence determination and characterization of proteins; biological functions of proteins; Denaturation & renaturation of proteins.

Unit II:

Carbohydrates–classification, structure and physicochemical properties, biological importance; Monosaccharides, Oligosaccharides and Polysaccharides; carbohydrate derivatives and glycoconjugates.

Unit III:

Lipids – classification, biological importance;fatty acids– classification, structure physicochemical properties; Structureand biological roles of triglycerides, phospholipids, sphingolipids, cholesterol, lipid derivatives and lipid conjugates.

Unit IV:

Nucleic acids – classification, structure - nucleotides, purine and pyrimidine bases physicochemical properties of nucleic acids, biological role ; DNA and RNA – structure and types; nucleosome and chromatin formation; DNA – histone interactions; DNA denaturation and renaturation kinetics –Tm, Cot curve and C-value paradox.

Suggested Reading:

1. Nelson.D.L, Cox. M. M. (2017). "Lehninger's Principle of Biochemistry".7th Edition.W H Freeman, , USA

2. Murray. R.K,Granner.D.K, Mayes. P. A, Rodwell. V. W. (2012)."Harper's Biochemistry" , 28th Edition, McGrawHill publications.

3.Donald Voet. (2017). "Fundamentals of Biochemistry, Life at the Molecular Level". 5th Edition, Wiley publications, USA

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4.West, E.S., Todd (1966). Textbook of Biochemistry Mason &Vanbruggen,4th Edition, Macmillian&Co., New York

5.LubertStryer.(2019). "Biochemistry",9th editionWH Freeman publications.

SEMESTER – I
COURSE-III
MICROBIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to help the students to:

- Understand basic aspects of microorganisms and their culture techniques, microbial nutrition, growth characteristics, reproduction cycles
- Learn about important groups of microorganisms including actinomycetes and different viruses including their life cycles, growth patterns and their control
- Gain deep insight about various microbial diseases including their sourse, symptoms, diagnosis and prevention.
- Acquaint with microbiological activities and advanced research aspects in the field of microbiology

Students can find jobs as microbiologists and as scientists in vaccine production industries such as in serum insttitue of India, Bharat Biotech etc

Unit I:

History and Scope of Microbiology; Classification and taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations; Characteristics and importance of Archaebacteria, Actinomycetes, Eubacteria, Pseudomonads, cyanobacteria, mycoplasma; Bacterial cell - Structural components and their functions; Gram positive and Gram negative bacteria.

Unit II:

Modes of nutrition – phototrophy, chemotrophy, methylotrophy, organotrophy, mixotrophy, saprophytic, symbiotic and parasitic modes of nutrition; Sterilization techniques – Physical, chemical and radiation; Culture media – types, batch and continuous cultures; chemostat;

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Microbial Growth curve and kinetics, Direct and Indirect methods of microbial growth; Effect of pH and temperature on microbial growth; Preservation of cultures (glycerol stocks, freeze drying).

Unit III:

Virus - morphology, characteristics and life cycle (ØX174, t4, HIV, Rota virus); Methods of culturing of viruses; Biology of subviral agents – Viroids, Prions, Satellite viruses; Antiviral agents- chemical and biological agents; Inactivation of viruses – photodynamic inactivation; Yeasts – morphology, characteristics and reproduction; Molds –morphology, characteristics and reproduction.

Unit IV:

Microbial diseases – Source, Symptoms, Diagnosis and Prevention – bacterial infections (Cholera, Typhoid, Hepatitis B, tuberculosis), viral infections (Polio, Rabies, small pox, HIV), fungal infections (systemic mycoses, candidiasis), protozoan diseases- Malaria, Trypanosomiasis).

Suggested Reading:

1. Willey, Sherwood and Woolverton (2007). "Prescot'sMicrobiology" 7th Edition, McGraw-Hill Science Engineering

2. Gerard J. Tortora, Berdell, R. Funke, ChristineL. Case (2014)."Microbiology: AnIntroduction". 12th Edition, BenjaminCummings, Pearson Publishers

3. Pelczar MJ, Chan ECS, andKrieg NR (1986). "Microbiology". 5th Edition, McGrew-Hill, New York

4.R.C.DubeyandD.K.Maheswari (2012). "ATextbookofMicrobiology", Revised Edition, S.Chand Publishers, New Delhi

5. FM.Frebisher (1974). "Fundamentals of Microbiology" 9th edition, Thomson Learning

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SEMESTER – I
COURSE-IV
ANALYTICAL TECHNIQUES

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of this course, the students will have the knowledge of:

- Basic aspects of instrumentation and applications of various biophysical teachniques used for analysis of biomolecules
- Different techniques such as microscopy, spectroscopy, X-ray diffraction, flow cytometry, centrifugation, electrophoresis, chromatography, radioisotopes and electrochemistry
- Practical experience in handling the instruments associated with various analytical techniques
- Biophysical and biochemical properties of the cells and molecules revealed through advanced instrumentation technology

After completing this course, students can find opportunities in Research and Development laboratories and pharma industries

Unit I:

Microscopy- Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy; Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, NMR spectroscopy; Spectrofluorimetry and mass spectrometry, X-ray diffraction; Flow cytometer.

Unit II:

Chromatography - Principles and applications of gel-filtration, ion-exchange and affinity chromatography, TLC, GLC and HPLC.

Centrifugation - Basic principles of sedimentation. Types of centrifuges. Applications of preparative and analytical ultra-centrifuges.Principle and applications of lyophilization.

Unit III:

Electrophoresis - General Principle of electrophoretic techniques, Poly Acryl amide Gel Electrophoresis, Isoelectric focusing, Isotachophoresis, 2-D Electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis of DNA and RNA. Blotting techniques.

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Unit IV:

Stable and radioactive isotopes. Detection and measurement of radioactivity.

Applications of radioisotopes in biological sciences, Autoradiography, Non-isotopic tracer techniques.

Principles and range of electrochemical techniques. Principles and applications of Ion-selective and gas sensing electrodes, Operation of pH electrodes and Oxygen electrodes.

Suggested Reading:

1. Keith Wilson and John Walker (2010). "Principles and Techniques of Biochemistry and Molecular Biology".7th edition, Cambridge Univeristy press
2. Upadyay, Upadyay and Nath(2016). "Biophysical chemistry principles and techniques" Himalaya publishing.
3. B.L Williams and Keith Wilson (1979)."A Biologists guide to Principles and techniques of practical Biochemistry". 2nd Edition, London
4. Rodney Boyer (2001). "Modern experimental Biochemistry 3rd Edition, PearsonEducation., USA

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I SEMESTER PRACTICALS

Cell Biology Lab

1.Microscopic observation of cell tissues

2.Observation of stages of mitosis and meiosis

3.Mitosis in onion root tip cells by Squash method

4.Arrest and observation of chromosomes after colchicine treatment in onion roots

5.Blood smear preparation and identification of cells

6.Total RBC count

7.Separation of cell organelles

Biomolecules Lab

1.Qualitative analysis of proteins

2.Quantitative analysis of proteins

3.Qualitative analysis of carbohydrates

4.Quantitative analysis of carbohydrates

5.Qualitative analysis of lipids.

6.Quantitative analysis of nucleic acids.

Microbiology Lab

1.Introduction to sterilization techniques.

2.Preparation of liquid and solid media for growth of microorganisms.

3.Isolation of Bacteria from soil –serial dilution technique.

4.Simple Staining, acid fast staining, spore staining, Grams staining.

5.Biochemical tests for bacteria.

6.Pure culture techniques-streakplate, spread plate and pour plate.

7.Bacterial growth curve.

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Analytical Techniques Lab

1.Microscopic examination.

2.Spectroscopic determination of nucleic acids and proteins.

3.Separation of biomolecules by Paper chromatography and Thin Layer Chromatography

4.Subcellular fractionation by differential centrifugation.

5.Polyacrylamide gel electrophoresis of proteins.

6.Qualitative determination of nucleic acids by agarose gel electrophoresis.

7.Preparation of buffers and pH determination by pH meter.

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SEMESTER – II
COURSE-I
MOLECULAR BIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: Upon completion of the course, students should be able to:

- Understand the central dogma of life and learn different DNA replication and repair mechanisms
- Acquire knowledge on post transcriptional and post translational modifications and their role in protein expression
- Study the concept of genetic code and inhibitors for transcription and translation process.
- Develop diagnostic applications to identify gene defects and their disorders

Students after completing this course will work as molecular biologists, research scientists in molecular diagnostic laboratories and industries

Unit I:

Models of DNA Replication Origin and direction of replication, Semi discontinuous replication, DNA polymerases of prokaryotes and their mechanism of action, Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases, Replication strategies for replicating circular DNA:φ mode replication,σ mode or rolling circle replication and D-loop replication; Inhibitors of replication.

Unit II:

DNA Repair mechanisms, Photoreactivation, Excision Repair mechanism,Postreplication repair mechanisms-recombination repair, mismatch repair system, SOS response, transcription-repair coupling. Recombination-models of general recombination; Holliday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination; Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

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Unit III:

Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiationof transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes, Post transcriptional processing of pre-mRNA-addition of Cap to the 5'end, Polyadenylation to the 3'end, mechanism of intron removal and exon splicing, Processing of r-RNA, Self-splicing of introns, Processing of tRNA, Inhibitors of RNA synthesis.

Unit IV:

General features of genetic code, Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes –aminoacylation of tRNA, protein synthesis-initiation, elongation and chain termination, Protein synthesis inhibitors, Post translational modifications of proteins.

Suggested Reading:

1. Lehninger (2017). "Principles of Biochemistry", David L.Nelson,Michael M.Cox 7th Edition,W.H.Freeman& Co

2.Bruce Alberts, Dennis Bray,JulianLewis,MartinRaff, KeithRoberts,andJamesDWatson (2002). "MolecularBiologyof theCell" 4th Edition, GarlandScience, New York

3. Donald Voet,Judith G.Voet (2010). "Biochemistry",4th Edition, JohnWiley&Sons

4. Watson(2017). "MolecularBiologyofthegene", 7th edition, Pearson Education, USA

5. Harvey Lodish, David Baltimore (2000). MolecularCell Biology, 4th Edition, W.H.Freeman Publisher.

6. DFriefelder(2014). MolecularBiology, 2nd Edition, Narosa Publishing House

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SEMESTER – II
COURSE-II
ENZYMOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course, the students will acquire and understand:

- The basic knowledge on biochemical catalysts, the crucial molecules involved in homeostasis among the cellular processes and functions in the biological system to the students
- The structure, nomenclature, classification and characteristic properties of enzymes, their activity, mechanism of action with substrates and their regulation.
- Kinetics of enzymes and helps the students to further explore novel enzymes in nature.
- Isolation, characterization and purification of enzymes from a biological source, which paves a platform for students to work in several research laboratories, medical field and food industries.

Successful completion of this course will enable the students to work as biochemists in industry, experts in Enzyme technology, Food industry etc.

Unit I:

Enzymes - Classification, nomenclature, properties, assay, Units of enzyme activity; Factors affecting enzyme activity; Enzyme – substrate complex formation by Fisher and Koshland models, Active site mapping, Modern concepts of evolution of enzyme catalysis.

Unit II:

Enzyme kinetics - Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots, Significance of Vmax, Km, Kcat, specificity constant (Kcat/Km); Kinetics of multisubstrate reaction - Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms, Enzyme inhibitions – competitive, non-competitive, uncompetitive inhibition, irreversible inhibition, Determination of KI values.

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Unit III:

Enzyme catalysis – General acid – base, electrostatic, covalent, metal – ion catalysis, Proximity and orientation, Mechanism of reaction catalyzed by chymotrypsin, carboxypeptidase, lysozyme, ribonuclease; Mechanism of catalysis with coenzymes – pyridoxal phosphate, flavin nucleotides, thiamine pyrophosphate, biotin.

Unit IV:

Enzyme regulation – Allosteric enzymes (ATCase), Symmetric and sequential models of allosteric enzymes and their significance; Feedback inhibition and feed forward stimulation, Isoenzymes – Lactate Dehydrogenase, Multienzyme complex systems – Pyruvate dehydrogenase complex; Methods for isolation and purification of enzymes.

Suggested Reading:

1. Palmer T., Bonner P (2007). "Enzymes" 2nd Edition, Woodhead Publishing
2. Alan Fersht, (1984). "Enzyme structure and mechanism". 2nd Edition, W. H. Freeman & Co Ltd, New York
3. Khan M.Y., Khan Farha, (2015). "Principles of enzymology technology:, Eastern Economy Edition, PHI Learning Pvt Ltd, Bangalore
4. Colowick and Kaplan, (2013). "Methods in enzymology" 1st Edition, Academic Press, USA
5. Segel IH (1993). "Enzyme kinetics": 1st Edition, Wiley Interscience, India

SEMESTER – II
COURSE-III
IMMUNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completing the course, the students will be able to:

- Learn the fundamental knowledge on the components of immune system and the mechanisms of their action involved in immune response against pathogenic infections.
- Understand various immunotechniques associated with antigen – antibody

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interactions, hybridoma technology and vaccine development, which gives scope on therapeutic and diagnostic areas.

- Apply immunotechniques in the manufacture of monoclonal antibodies, genetically engineered vaccines and decipher drugs for autoimmune and immunodeficiency disorders
- Understand various therapeutic aspects, and help them develop pharmaceutical drugs inorder to avert disorders and diseases

Students after completion of the course can get placement as Research fellows and Project Fellows/Associates in various National / State level research institutes of Immunology and molecular biosciences

Unit I:

Types of immunity – Innate and adaptive; Antigens – properties, Haptens, Adjuvants; Immunoglobulins – structure, types and biological activities; Theories of antibody diversity; Organs of the immune system - Thymus, bone-marrow, spleen, lymph node.

Unit II:

Cells of Immune system - T and B lymphocytes – Origin, activation, differentiation, characteristics and functions; Humoral and cell-mediated immune responses - Immunological memory and immune tolerance; Antigen presenting cells - Processing and presentation of antigens, Major Histocompatibility Complex and its role in immune response.

Unit III:

Antigen-antibody interactions - Precipitation reactions – single immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions - Heme agglutination; complement fixation - components and activation; Immunofluorescence, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications; Vaccines- production of conventional and recombinant vaccines.

Unit IV:

Hypersensitivity: immediate (type I, type II, type III and type V) and delayed hypersensitivity (type IV); Immunodeficiency diseases – SCID and AIDS; Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases; Tissue transplantation – types, graft rejection and graft acceptance, immunosuppressive agents.

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Suggested Reading:

1. Delves PJ, Martin, SJ, Burton DR and Ivan M. Roitt (2013). "Essential immunology" 13th Edition, Wiley Blackwell
2. John W.Kinball (1986). "Introduction to Immunology". Revised Edition, Macmillan, USA
3. D.M. Weir and Stewart (1997). "Immunology". 8th Edition, Churchill Livingstone Publisher
4. Punt J, Stanford S, Jones P and Owen JA (2018). "Kuby Immunology". 8th Edition, WH Freeman, UK

SEMESTER – II
COURSE-IV
BIOINFORMATICS & BIOSTATISTICS

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to help students understand:

- The basic bioinformatics tools and their importance, introduces them to the applications of computational methods in Biology.
- How to retrieve information from different biological databases by bioinformatic approaches.
- The biostatistical concepts, statistical tools to work with biological data and understand the data by using tests of significance Chi-square test and ANOVA.
- Bioinformatics and biostatistics which paves a platform for research studies on field data.

Students find jobs as Bio-statisticians, Data scientists in Bioinformatics industry, as Project Scientists and may also get an opportunity in computational drug designing fields and pharmaceutical industries

Unit-I

Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

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Unit-II

Introduction to Bioinformatics, Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases; An overview of types of biological databases – NCBI, EMBL, Gen bank, Swiss prot, and PDB. Database searching using BLAST and FASTA. Human Genome Project.

Unit-III

Sequence alignment-Introduction and significance of sequence alignments. Pair wise and Multiple sequence alignment. Gene and Genome annotation – Tools used. Physical map of genomes. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery. Molecular phylogeny - Concept methods of tree construction.

Unit-IV

Brief description and tabulation of data and its graphical representation. Measures of central tendency - mean, median, mode. Measures of dispersion- range, variance, standard deviation. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – t- test, Chi-square test, ANOVA.

Suggested Reading:

1. Stephen Misener & S.A. Krawez. (2000). "Bioinformatics Methods and Protocols", 1st Edition, Humana Press,
2. R. Durbin, S. Eddy, A. Krogh & G. Mitchson. (2002) Biological sequence analysis. 7th Edition, University Press, Cambridge
3. C.P. Freidman & J.C. Wyatt, (1997) Computers and machine: Evaluation methods in Medical information. Springer Verlag, New York.
4. M.J. Bishop & Rawling, (1997) DNA and Protein structure analysis: A Practical approach. Oxford University Press.
5. Mount DW (2004). "Bioinformatics – "Sequence and Genome Analysis" 2nd Edition, Cold Spring Harbor Laboratory Press, U.S
6. Arthur M.Lesk (2013). "Introduction to Bioinformatics". 4th Fourth Edition, Oxford University Press, Oxford.
7. Mahajan and Srimathi (2018). "Methods in biostatistics". 9th Edition. Jaypee brothers

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Medical Publishers,

8. PSS Sundar Rao & J Richard. (2012). "An introduction to biostatistics and Research methods" 5th Edition. PHI Learning, New Delhi

SEMESTER- II PRACTICALS

Molecular Biology Lab

1.Isolationof DNAfrombacterial,plantandanimalcells.

2.IsolationofRNA fromyeastcells.

3.Estimationof DNA and RNA by UV absorption method and determination of purity of nucleicacids.

4.Agarosegel forRNA,DNA,blotthegel

5.Determination of sugar and phosphate ratios in DNA and RNA samples.

6.Determination of melting Temperature(Tm)of DNA.

Enzymology Lab

1.Assay of Amylase from saliva

2.Assay of Acid phosphatase from potato

3.Effect of substrate concentration on enzyme activity

4.Time course effect on enzyme activity

5.Effect of pH on enzyme activity

6.Effect of temperature on enzyme activity

7.Isoenzymes of LDH – electrophoretic separation and specific staining technique-demonstration

Immunology Lab

1.Determination of A, B, O and Rh blood groups in human beings

2.Diagnostic test for typhoid fever

3.VDRL Test

4.Bleeding time and clotting time

5.Total WBC count

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6.Radial Immunodiffusion

7.Rocket immunoelectrophoresis- demonstration

8.Enzyme Linked Immuno Sorbent Assay (ELISA)- demonstration

Bioinformatics and Biostatistics Lab

1.Searching Data from NCBI Database.

2.Working on EMBL.

3.Searching structural data from PDB.

4.Genome Map viewer from NCBI.

5.Database search using BLAST.

6.Sequence alignments.

7.Measures of dispersion- Standard deviation

8.Correlation coefficient calculation

9.Tests of significance - one way ANOVA.

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SEMESTER – III
COURSE-I
ENDOCRINOLGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: Upon successful completion of the course, the students will be able to:

- Learn basic knowledge on endocrine molecules and their role in biological processes.
- Gain knowedge on mechanisms involved in cell to cell communication and deciphering the cellular functions at the target sites.
- Develop knowledge on the structure, chemical nature, synthesis, signal transduction mechanism through receptor ligand complex, functions and regulation of endocrine hormones.
- Understand the molecular mechanisms underlying the non communicable diseases

After completing the course students can work as endocrinologists in medicare units, develop the preventive strategies in pharmaceutical companies, research industries and diagnostic laboratories.

Unit I:

Hormones - Classification, chemistry, biosynthesis, secretion, regulation, transport and assays (RIA, ELISA); Signal cascade mechanisms - Autocrine, paracrine & endocrine systems; Growth factors – EGF, PDGF, VEGF, IGF; Second messengers – Ca, calmodulin, inositol, cAMP, cGMP; Receptor mediated signal transduction; Insulin signaling, MAPK pathway.

Unit II:

Hypothalamic and pineal hormones - structure, function, regulation and abnormalities of hypothalamic releasing hormones and inhibitory hormones, melatonin and serotonin;
Thyroid and parathyroid hormones - structure, biosynthesis, function, regulation and abnormalities of thyroid and parathyroid hormones.

Unit III:

Hormones of Pancreas and Gastro intestine - structure, biosynthesis, secretion, function, regulation and abnormalities of insulin and glucagon, gastrin, secretin, cholecystokinin; Adrenal hormones - Structure, biosynthesis, secretion, function, regulation and abnormalities of adrenaline and noradrenaline, corticosteroids.

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Unit IV:

Hormones of Reproduction - structure, biosynthesis, secretion, function, regulation and abnormalities of testosterone, estrogens, progesterone, Human chorionic gonadotropin; Hormonal regulation of menstrual cycle.

Suggested Reading:

1. HelmreichErnst J.M. (2001). "The Biochemistry of Cell Signalling". Oxford University Press, New York.
2. John T Hancock (2016). "Cell signalling". 4th Edition, Oxford University Press, UK.
3. Smith C. A. and WoodE. J. (1996). "Cell biology". 2nd Edition,Chapman and Hall Publications, London
4. Harvey Lodish et al (2016). "Molecular Cell Biology". 8th Edition, W.H.Freeman, Macmillan publisher, New York.
5. ShlomoMelmed, Richard J Auchus, Allison B Goldfine, Ronald J Koenig, Clifford J Rosen, Robert Hardin Williams (2011). "Williams Text book of Endocrinology". 12th Edition, SaundersElsevier Publisher, Philadelphia, US.

SEMESTER – III
COURSE -II
PHYSIOLOGY & BIOENERGETICS

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completion of the course the students will learn:

- The physiological processes of living system such as digestive, renal, nervous, muscular, circulatory and respiratory systems
- The fundamental energetics and the energy transfer mechanisms of biochemical processes.

Students after completion of this course can find oppotunnities as research fellows / associates, project scientists in reputed National and International research institutes.

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Unit I:

Introduction- Digestion- digestive processes at various regions of digestive system, regulation of gastric secretion and motility, intestinal secretion and motility, role of gastrointestinal hormones; Renal physiology- structure of nephron, glomerular filtration, tubular reabsorption and secretion. Regulation of water and mineral excretion, counter current multiplier and exchanger, renal role in acid base balance.

Unit II:

Nerve physiology-Structure of neuron and synapse, action potential, conduction of never impulse, synaptic transmission, neurotransmitter systems, Blood brain barrier; Muscle physiology- skeletal and smooth muscle, types of muscle contraction, Neuromuscular transmission.

Unit III:

Circulatory physiology - Formation and composition of blood, total and differential counts in blood, Development of erythrocytes, leukocytes and platelets, Plasma proteins and blood clotting mechanism, Erythrocyte Sedimentation Rate; Cardio physiology- functional anatomy of heart, genesis and spread of cardiac impulses, cardiac cycle, cardiovascular regulatory mechanisms, basic E.C.G; Respiratory

physiology- functional anatomy of air passages and lung, respiratory muscles, mechanism of respiration, regulation of respiration.

Unit IV:

Laws of thermodynamics, Gibbs free energy, relevance of entropy and enthalpy in biological systems and reactions; Biological oxidation, high energy compounds; proton gradients, role of transporters and channels; Electron Transport Chain and its inhibitors; Biological fluorescence,Bioluminescence.

Suggested Reading:

1.Pal G.K. (2018). "Medical Physiology". 3rd Edition, Ahuja Publishing House, New Delhi.

2.Guyton and Hall (2015). "Medical Physiology". 13thEdition, Elsevier Health Science Publisher, US.

3.Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason X.-J. Yuan (2012).

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"Ganong's Review ofMedicalPhysiology". 24th Edition. , McGraw-Hill Medical Publisher, India.

4.Nelson.D.L, Cox. M. M. (2017). "Lehninger's Principle of Biochemistry". 7th Edition. W H Freeman, , USA

5.Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson (2001). Molecular Biology of the Cell, 4th Edition, Garland Science Publisher, New York.

6.Geoffrey M. Cooper and Robert E. Hausman (2013). "The Cell: A Molecular Approach" 6th Edition,Sinauer Associates Incpublisher, US.

SEMESTER – III
COURSE -III
INTERMEDIARY METABOLISM

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome:After completing the course, the students will be able to :

- Know the anabolic and catabolic processes of carbohydrates, aminoacids, lipids and nucleic acids.
- Understand the integrated approach of interrelated pathways of catabolism and anabolism with a focus on metabolic disorders at molecular level.
- Understand the molecular mechanisms underlying the development of non communicable diseases

After successful completing the course, students can work as endocrinologists in medicare units, develop the preventive strategies in pharmaceutical companies, research industries and diagnostic laboratories.

Unit I:

Carbohydrate metabolism - Glycolysis and its regulation, TCA cycle and its regulation; Glyoxylate cycle, Gluconeogenesis and its regulation; HMP shunt pathway; Uronic acid pathway, Glycogen metabolism; Metabolism of monosaccharides; In born errors of carbohydrate metabolism.

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Unit II:

Amino acid metabolism - Ketogenic and glycogenic amino acids, Essential and Non essentialaminoacids, urea cycle and its regulation; Biosynthesis and regulation of branched chain amino acids, aromatic amino acids; In born errors of amino acidmetabolism.

Unit III:

Lipid metabolism – Oxidation of fatty acids, Biosynthesis of fatty acids and regulation; Metabolism of arachidonic acid; formation of prostaglandins, thromboxanes, leukotrienes, Biosynthesis of triglycerides; Metabolism of phospholipids; Biosynthesis of cholesterol and its regulation; In born errors of lipid metabolism.

Unit IV:

Nucleic acid metabolism - Biosynthesis and degradation of purines and pyrimidines and their regulation

– Denovo and salvage pathways; regulation of ribonucleotidereductase; In born errors of nucleic acid metabolism.

Suggested Reading:

1.A. White, P. Handler, and E. L. Smith (). "Principles of Biochemistry". 5th Edition, McGraw-Hill Kogakusha Ltd, USA.

2.Nelson.D.L, Cox. M. M. (2017). "Lehninger's Principle of Biochemistry". 7th Edition. W H Freeman, , USA.

3.West, E.S., Todd (1966). "Textbook of Biochemistry", 4th Edition, Macmillian&Co. publisher, New York, USA.

4. LubertStryer.(2019). "Biochemistry",9th edition WH Freeman publications, USA.

5. David E.Metzler (2003). "Biochemistry", 2nd Edition, Academic Press Imprint, USA.

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SEMESTER – III
COURSE -IV
GENE REGULATION AND GENETIC ENGINEERING

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completing the course, the students will be able to:

- Gain focus on various gene regulatory mechanisms in Prokaryotes and Eukaryotes.
- Get expertise in this emerging area on recombinant DNA technology, on basic aspects of genetic engineering and gene transfer techniques including transformation and transfection and applications of genetic engineering in agriculture, animal husbandry and medicine.
- Generate awareness in the construction and screening of genomic and cDNA libraries with the help of reporter genes and molecular markers.

After completion of this course the students will get an opportunity to work as Scientists / Research Executives / DNA Finerprint Experts / Prenatal Diagnosis Experts in Bioscience Industry and Medicare units

Unit I:

Structure and function of *lac* operon, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system, Function and regulation of *trp*operon, Attenuation of *trp*operon, *ara*operon - dual functions of the repressor, Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis.*

Unit II:

Structural changes in the eukaryotic active chromatin - hypersensitive sites, chromatin remodeling, Levels of eukaryote gene control - Control at the level of transcription, processing of RNA, mRNA stabilization in the cytoplasm and translation of mRNA; Eukaryote promoter and enhancer sequence organization, Interaction of eukaryote transcriptional factors with DNA - helix-turn-helix motif, zinc- finger motif, leucine zipper, helix-loop-helix motif; Regulation of galactose metabolism in yeast; Steroid hormone induced gene expression; Regulation of gene expression by anti-sense RNA.

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Unit III:

Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing; Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, Hosts - Prokaryotic: *E.coli, B.subtilis,* Eukaryotic:Yeastandmammaliancelllines;Ligationoffragments - Cohesiveandbluntends.

Unit IV:

Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria; Genomic and cDNA libraries, Identification of recombinants - structural and functional analysis of recombinants; Design and preparation of DNA and RNA probes for hybridization, Southern and Northern blotting, South-Western blotting, PCR, DNA fingerprinting; Expression of cloned genes inbacteria, yeast, animal and plant cells; Biological, Medical and Industrial applications of recombinant DNA technology, Transgenics - Making Golden rice and Dolly.

Suggested Reading:

1.BenjaminLewin (2003). "Genes-VIII". (Oxford), Pearson, 2003, USA

2.Old andPrimrose (2001). "Principles of Gene Manipulation" 6th Edition. Wiley–Blackwell publisher.

3.Glick B, Paternak JJ and Cheryll (2010). "Molecular Biotechnology, principles and applications of recombinant DNA", 4th Edition, ASM Press, Washington, DC

4.Watson (2017). "Molecular Biology of the gene", 7th edition, Pearson Education, USA.

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SEMESTER-III PRACTICALS

EndocrinologyLab

1.Microscopic observation of endocrineglands
2.Estimation of sugar by anthronereagent
3.Study of scavanging activity (Indirectmethod)
4.Pregnancy Test (stripmethod)
5.Effect of iodine onmetamorphosis
6.Effect of thyroid hormone onmetamorphosis
7.Estimation of plasma insulin by RIA-demonstration
8.Estimation of TSH by ELISA-demonstration

Physiology and Bioenergetics Lab

1.Microscopy
2.RBC count &WBCcount
3.Differential leucocyte count by Leishman' sstaining
4.Estimation of Haemoglobin by Sahli's acid haematinmethod
5.Determination of Packed cell volume(PCV)
6.Determination of Erythrocyte sedimentation rate(ESR)
7.Determination of Coagulation time & Bleedingtime
8.Determination of bloodgroup

Intermediary Metabolism Lab

1.Isolation of casein frommilk
2.Preparation of lactalbumin frommilk
3.Estimation of reducing sugar by DNSA (dinitrosalicylic acid)method
4.Titration of glucose by Benedict'smethod
5.Estimation of urea by Diacetylmonoximemethod
6.Estimation of creatinine in serum
7.Estimation of cholesterol by ZAK'smethod

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Gene regulation and Genetic Engineering Lab

1.Culture of *E.coli*cells& plasmidisolation

2.Preparation of competentcells

3.Calcium chloride mediatedtransformation

4.Primer design forPCR

5.Polymerase chainreaction

6.Restriction fragment lengthpolymorphism

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SEMESTER – IV
COURSE -I
PLANT AND ENVIRONMENTAL BIOCHEMISTRY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course the students will be able to:

- Learn the physiological processes of plant at molecular level.
- Understand the molecular mechanisms and biochemical pathways involved in plant physiology.
- Gain the knowledge on ecosystem, natural resources, environmental pollution and develop awareness on environment conservation strategies.

Students after completion of this course can work as JRF/ research associates / Scientists in State and Central agricultural institutes like CTRI, NBPGR, ICRISAT, as Scientfic officers in private industries like DOW, Dupont, Bayer, Corteva and as regulatory officers in environmental pollution control board.

Unit I:

Photosynthesis – components and mechanisms; photophosphorylation - Cyclic and Non-cyclic mechanisms; Proton gradient and ATP synthesis, CO_2 fixation in C3, C4 and CAM plants; factors effecting photosynthesis, regulation of photosynthesis; Mechanism of photorespiration and its significance.

Unit II:

Nitrogen fixation – types and mechanisms, seed germination and dormancy, Factors effecting seed germination; Secondary metabolites in plants – Nature, distribution and function; Structure, physiological function and mechanism of action of phytohormones – auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Unit III:

Renewable and non-renewable resources - Forest resources, Water resources, Mineral resources, Food resources, Energy resources; Ecosystem - Structure and function, Energy flow, Ecological succession, food chains, food webs and ecological pyramids; Forest, Desert and Aquatic ecosystems.

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Unit IV:

Environmental Pollution - Definition, cause, effects and control measures of Air pollution, Water pollution, Soil pollution; Solid waste Management - Causes, effects and control measures of urban and industrial wastes; Role of Information Technology in Environmental Protection.

Suggested Reading:

1.Mukherji, S and Gosh A. K. (2009). " Plant Physiology", 3rd Edition, New Central Book Agency,Kolkata.

2.A. Slater, N.W. Scott and M.R. Fowler (2008). "Plant Biotechnology, the genetic manipulation of plants", 2nd Edition, OxfordUniversity press, Oxford

3.Hopkins W. G and Huner N. P. A. (2008)."Introduction to Plant Physiology", 4th Edition, John Wiley & Sons Inc. NewYork.

4.Hans-Walter Heldt and BirgitPiechulla(2011). "Plant Biochemistry", 4th Edition, Academic Press, USA.

5. Arun Kumar V, Siva Kumar K, SenthilKumar N (2010)."Plant Biochemistry", APH Publishing Corporation, New Delhi.

6.NeelimaRajvaidya andDilip KumarMarkandey (2005). "Environmental Biochemistry".APH Publishing Corporation, New Delhi.

7. P.W. Ed. Hochachka, T. P. Mommsen (1995). "Environmental and Ecological Biochemistry". 1st Edition,Elsevier Science, USA.

SEMESTER – IV
COURSE -II
CLINICAL BIOCHEMISTRY AND HUMAN NUTRITION

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of this course students will:

- Learn the concepts on analysis and diagnosis methods of liver, gastrointestine and kidney diseases.
- Explore knowledge on nutritive role, bioavailability of foods and recommended dietary allowances of macro and micronutrients.

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- Illustrate prenatal diagnosis using fetal blood examination.

After completing this course the student will get an opportunity to work as clinician, Lab Assistant / Project Assistant / JRF in Medical Research Institutes like Indian Council for Medical Research, as Dietician and Nutritionist in the Hospitals, Food Safety Officers in State and Central Government. Organizations.

Unit I:

Introduction to Clinical Biochemistry - Introduction and maintenance of clinical biochemistry laboratory, quality control in laboratory as per WHO standards, Selection of analytical methods, Collection and preservation of specimens; Pancreas function tests, renal function tests - osmolality and free water clearances, Liver function tests - bile pigments level, plasma changes, prothrombin time; Gastric function tests - gastric residuum examination, FTM, tubeless gastric analysis.

Unit II:

Prenatal Diagnosis - Newborn screening for PKU, cystic fibrosis and sweat tests. Prenatal diagnosis of diseases, Acetylcholinesterase test in amniotic fluid and fetal blood examination; Diagnosis of genetic diseases by molecular biology techniques (thalassemia, sickle cell diseases), DNA probes, restriction fragment length polymorphism (RFLP), polymerase chain reaction (PCR).

UnitIII:

Nutrients-Essential Nutrients and their classification.Carbohydrates dietary requirements; Nitrogen balance studies for Proteins, Biological values of proteins, protein quality improvement by supplementation and fortification; Dietary needs of lipids, essential fatty acids; Calorific values of foods, Basal metabolic rate, factors influencing BMR; role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin in regulation of body mass, malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women.

Unit IV:

Biological effects of non nutrients (dietary fibre), Antinutrients – Protease inhibitors, hemagglutinins, hepatotoxin, goitrogens, toxins from mushrooms; Biological effects of food contaminants –DDT, cadmium, mercury, lead, aflatoxins; Food allergy – role of allergens,

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diagnosis and management of food allergy; Vitamins - sources, physiological role and deficiency disorders of water soluble and fat soluble vitamins; functions and deficiency disorders of minerals.

Suggested Reading:

1. M. Swaminathan (1985). "Essentials of Food and Nutrition : An advanced text book", 2nd Edition, Bapcco publisher, Bangalore, India.

2.Thomas M. Devlin (2010). "Text Book of Biochemistry with clinical correlations", 7th Edition, JohnWiley publications.

3.R.S. Elkeles and A.S. Tavil (1983). "Biochemical aspects of human disease", Blackwell Scientific Publications.

4.Alan W. Gowenlock (1988). "Varley's Practical clinical Biochemistry", 5th Edition, Heinemann Medical Books,London.

SEMESTER – IV
COURSE -III
APPLIED BIOCEMISTRY AND CANCER BIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of this course the students will be able to:

- Deal and apply the advanced techniques in biological sciences.
- Gain knowledge on fundamental concepts and biochemical mechanisms of cancer biology.
- Acquire awareness on latest technology such as microarray concept, nanotechnology, plant and animal tissue culture techniques.
- Students also gain knowledge on fermentation and enzyme technology.

The course will enable the students to obtain employability in pharmaceutical companies, biochemistry and biotechnology related laboratories, medical and clinical fields and research laboratories.

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Unit I:

Molecular markers – RFLP, RAPD, SNPs, Chromosomal Walking, Chromosomal jumping, foot printing, gel shift analysis; Mapping Genes – Somatic cell hybridization mapping, FISH, Transposon tagging; RNA silencing by siRNAs and epigenetics; Microarrays – principle, types and applications; Gene therapy – types and applications.

Unit II:

Plant tissue culture - Culture conditions, components, types and its applications - Somatic embryogenesis, Micropropagation, Somatic hybridization, secondary metabolites production; Animal cell culture - Culture conditions, components, types and its applications; Stem cells – types and its applications.

Unit III:

Fermentation Technology - principle, types of fermenters and productions of citric acid, lactic acid, butanol, penicillin, streptomycin, riboflavin, vitamin B12, glutamic acid and single cell protein (SCP); Enzyme Technology- Immobilization of enzymes, types and its applications; Nanotechnology and its applications.

Unit IV:

Cancer biology – Morphological properties and growth characteristics of cancer cells; types of cancers and types of growth; Differences between benign and malignant tumors; Tumor markers; cellular protooncogenes- oncogene activation; Strategies of anticancer drug therapy – chemotherapy, gene therapy, Immunotherapy and Radiotherapy.

Suggested Reading:

1.Peter F Stanbury, Allan Whitaker and Stephen J. Hall (1995). "Principles of Fermentation Technology", 2nd Edition, Pergmanpress.

2.WulfCrueger andAnnelieseCrueger (1990). "Biotechnology: A Textbook of Industrial microbiology",Sinauer Associates Inc.,USA.

3.Old andPrimrose (2001). "Principles of Gene Manipulation",6th Edition. Wiley–Blackwell

4.Alen Weisman (1988)."Principles of Biotechnology", 2nd Edition, Surrey UniversityPress, New York.

5.L.E.Casida JR (2016). "Industrial Microbiology" 2nd Edition , New Age International Publishers.

6.R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G.Barry Pierce, I. Damjanov (2006). "The Biological Basis of Cancer", 2nd Edition, Cambridge University Press, UK.

7.R. A. Weinberg (2006). "The Biology of Cancer", Garland Science, New York.

SEMESTER – IV
COURSE -IV
OMICS, BIOETHICS AND RESEARCH METHODOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completing the course, the students will be able to:

- Acquire knowledge on advanced computational biology on proteins and genes.
- Study proteomics and genomics and understand online protein structure prediction tools and gene identification and sequencing tools.
- Study insilico analysis for novel genes and proteins.
- Understand the concepts of bioethics, intellectual property rights (IPR) and research methodology.
- Develop research articles and research proposals writing skills which is an entry step for research field.

After completion of this course the student can be placed as Data Scientists/ Computational Biologists in Bioinformatic companies and Research institutes as content writers in the academics.

Unit I:

Proteomics - Introduction, principle and techniques – 2D gel electrophoresis, 2D-DIGE, MALDI-TOF, Quadrupole Time-of-Flight (Q-TOF); Significance and applications of proteomics in modern biology; Molecular Modeling – Structure of protein at Primary, secondary, tertiary and quaternary level; Understanding Molegro Molecular viewer for protein 3D visualization – RASMOL.

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Unit II:

Genomics- Whole genome sequencing and/or analysis; Preparation of cosmid libraries, bacterial artificial chromosomal libraries, shotgun libraries;Sequencing - conventional sequencing (Sanger, Maxam and Gilbert Methods), automated sequencing, Sequence analysis – BLAST, Sequence assembly, Gene prediction; Comparative genomics - Orthologs, paralogs, andhomologs.

Unit III:

Introduction to Bioethics, Genetic Testing- Merits and Demerits; Human Genome Project Ethical, Legal, Social Issues (ELSI); Biosafety- Guidelines for Research in Transgenic organisms; Introduction of Genetically Modified Organisms into environment; Regulations to Biotech companies, Good laboratory practices (GLP), Good Manufacturing Practices (GMP), laboratory accreditation; Patenting and Intellectual Property Rights (IPR).

Unit IV:

Research Methodology – Basics, Origin and identification of problem, Literature survey, Formulation of hypothesis, Experimental design, Execution, Sampling, Analysis of data, Testing of hypothesis, Interpretation of research findings; Methodology for writing science report and program of writing, useof vocabulary, art of illustration and manuscript writing for publication in peer reviewed scientific journals; Preparation of project proposal- Project description, goals, work plan, progress reporting.

Suggested Reading:

1. Primrose S.B. (1998). "Principles of Genome Analysis: a guide to mapping and sequencing DNA from different organisms" , 2nd Edition, Blackwell Science, Oxford.
2. Paul H Dear (1997). "Genome Mapping: A practical approach", Oxford University Press, Oxford.
3. Alfonso Valencia and Blaschke(2001). "Developing Bioinformatics Skills" O'Reilly Media Inc. Publication.
4. Des Higgins and WillieTaylor (2000). "Bioinformatics: sequence, structure and data banks", Oxford University Press.
5. Zhumur Ghosh and Bibekanand Mallick (2008). "Bioinformatics: Principles and Applications", Oxford University Press.

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6. V. Sree Krishna (2007). "Bioethics and Biosafety in Biotechnology" 1st Edition, NewAgeInternationalPublishers.

7. M.K.Sateesh I.K. (2009). "Bioethics and Biosafety", International Publishing House Pvt.Ltd.

IV SEMESTER PRACTICALS

Plant and Environmental Biochemistry Lab

1.Estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments fromthe leaves.

2.Estimation of starch content by Anthronereagent.

3.Spectrophotometric estimation of Indole acetic acid in planttissues.

4.Determination of Gibberllic acid by half seedmethod.

5.Determination of protein under abioticstress.

6.Isolation of chloroplastDNA

Clinical Biochemistry and Human Nutrition Lab

1.Estimation of bloodglucose.

2.Estimation of bloodurea.

3.Estimation of creatinine inserum.

4.Estimation of uric acid inserum.

5.Estimation of serum totalprotein.

6.Estimation of Serumalbumin.

7.Estimation of Serumcholesterol.

8.Estimation of serumcalcium.

9.Estimation of serumphosphate.

1.Estimation of serumbilirubin.

Applied Biochemistryand Cancer Biology Lab

1.Isolation of genomic DNA from animal cellculture

2.Quantitative and quantitative analysis of genomic DNA isolated from animal cellculture

3.TLC of Plant tissue culturecompounds

4.Estimation of plant tissue cultureproteins

5.SDS PAGE of cell cultureproteins.

6.Immobilization of enzymes(demonstration)

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7.Primer designing foroncogenes

8.Gene expression analysis of oncogenes by polymerase chainreaction.

Omics, Bioethics and Research Methodology Lab

1.OMIM database and human geneticdisorders

2.Retrieve DNA sequence from database(NCBI)

3.Retrieve protein sequence from database(NCBI)

4.Retrieve protein structure fromdatabase(PDB)

5.KEGG database forpathways

6.Local alignment of DNA,protein

7.Global alignment of DNA,protein

8.Multiple sequencealignments

9.In silicorestrictionmapping